

Compact transportable CH₄ PAD gas analyzer based on quantum cascade laser

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Abstract— Compact transportable CH₄ photoacoustic gas analyzer based on PAD detector and quantum cascade laser at 7.65 μm was created.

Keywords— PAD detector, quantum cascade laser, methane detection.

I. INTRODUCTION

Monitoring the concentration of methane in the atmosphere in real time is an important task for the search for oil fields, since the presence of oil can be accompanied by the release of gas, control of the movement of biological objects, as well as control of gas pipeline leaks. This requires highly sensitive equipment that can be placed both on unmanned aerial vehicles, on vehicles, and in stationary or portable versions [1,2].

II. EXPERIMENTAL RESULTS

On the fig 1 the methane gas analyzer is shown. As a laser source for this compact device we used a QD7500CM1 QCL (Thorlabs, Inc.), which is a compact discrete semiconductor laser in the mid-IR range ($\lambda \sim 7.5\text{--}7.7 \mu\text{m}$). The QCL operates in a repetitively pulsed mode with a pulse repetition rate equal to the lowest resonant frequency of the differential PAD ($f_1 \sim 1770\text{--}1800 \text{ Hz}$). The control of the current and temperature of the QCL is carried out using the built-in controller

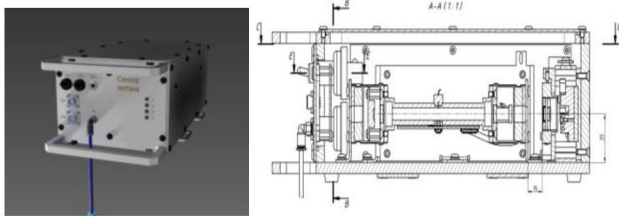


Fig. 1. Methane gas analyzer based on QCL

This system uses the photoacoustic detector PAD 90, which is described in [3]. An air sample is pumped through the PAD detector using a built-in pump and filter system, and the methane concentration is measured in real time. Figure 2 shows a diagram of measuring the methane concentration during the pumping of various calibrated mixtures. The

diagram also shows the results of measurements of the background concentration in the atmosphere and dry nitrogen.

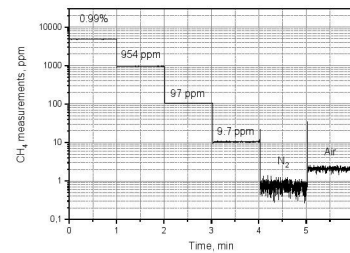


Fig 2. Diagram of measurement methane concentration for different calibration mixers, dry nitrogen and air.

The compact transportable photo-acoustic (PA) methane gas analyzer (315×165×110 mm, 2.5 kg) based on a quantum cascade laser (QCL; $\sim 7.7 \mu\text{m}/1800 \text{ Hz}/24 \text{ mW}$), a resonant differential PA detector, and a sealed gas-filled cell was created. The measurement of methane concentration below the background value in the air ($\sim 0.3 \text{ ppm CH}_4$) is shown; the standard dispersion was (1σ) $\approx (10\text{--}11) \text{ ppb CH}_4$ with an integration time of 10 s. Under conditions of temperature instability (or emission wavelength) of QCL when normalized to a gas-filled cell, the relative measurement error of the CH₄ concentration does not exceed 3%. For unification of this device for other gases we need only to change a QCL laser and reference cell.

ACKNOWLEDGMENT

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